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Are International Fund Flows Related to Exchange Rate Dynamics?

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Abstract Employing monthly data for 53 countries between 1996 and 2015, we investigate the relationship between international fund flows and exchange rate dynamics. We find strong co-movement between funds flows (as measured with the EPFR Global data base) and bilateral real exchange rates vis-à-vis the USD. This holds both for equity flows and bond flows. However, bond flows have a more significant relationship with RER appreciation than equity flows in developing countries, while in developed countries equity flows play a more important role. Under a more flexible exchange rate regime the real exchange rate appreciation associated with fund flows is higher.

Keywords International fund flows · Exchange rates · Exchange rate regime · Dynamic panel data model

JEL Classification E44 · F30 · F31 · G15 · G23

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1 Introduction

Explaining exchange rate dynamics has been an important issue in international finance since the breakdown of the Bretton Woods System (De Grauwe and Dewachter 1993; Williamson 2009; An and Wang 2012; Balke et al. 2013; Tang and Zhou 2013). Due to their significant increase during the past few decades, the role of international capital flows in exchange rate dynamics received considerable attention in this line of literature (see, for instance, Brooks et al. 2004; Calvo et al. 1993; Caporale et al. 2015; Combes et al. 2012; Jongwanich and Kohpaiboon 2013; Gyntelberg et al. 2014; Kosteletou and Liargovas 2000).¹ There is evidence that large capital inflows lead to real exchange rate appreciation, but not all types of capital flows may have the same effects (Combes et al. 2012). This paper investigates the relationship between one type of international capital flows, namely international fund flows, and exchange rate dynamics.

International fund flows are cross-border investments in domestic equity and bond instruments by global funds, including mutual funds, exchange traded funds (ETFs), closed-end funds, insurance-linked funds and hedge funds (Li et al. 2015). We focus on international fund flows for the following reasons. First, due to increased financial integration and capital market liberalization, international fund flows have increased rapidly since the 1990s. The assets under management by international funds (covered by the EPFR Global database) increased more than 150 times, expanding from 0.15 trillion US dollars in 2000 to 25 trillion US dollars in 2015. Compared with long-term capital flows, fund flows are more volatile and play an increasingly important role in the transmission of shocks (Jinjarak et al. 2011; Raddatz and Schmukler 2012; Gelos 2013). Given the rapid increase and high volatility of fund flows, it is of great academic and policy relevance to investigate their impact on exchange rate dynamics. Second, existing studies suggest that financial portfolio investments play a more important role in exchange rate dynamics than other types of capital flows such as FDI and bank loans (Combes et al. 2012; Jongwanich and Kohpaiboon 2013). International fund flows are mainly portfolio investments.

The following questions are addressed in this research: (i) What is the relationship between international fund flows and real exchange rate (RER) dynamics? (ii) Is this relationship different for developed and developing countries? To answer these questions, we employ dynamic panel data models. We use fund flow data from the EPFR Global database. These data are monthly, which enables us to detect the influence of fund flows on exchange rate dynamics very accurately. Our sample consists of 53 countries over the period from January 1996 to June 2015, including 18 developing countries and 35 developed countries.

We find strong evidence for co-movement between fund flows and bilateral real exchange rates vis-à-vis the USD. This holds both for equity flows and bond flows. However, bond flows have a more significant relationship with RER appreciation than equity flows in developing countries, while in developed countries equity flows play a more important role. We also examine the role of the exchange rate regime and

¹ International capital flows (measured as the sum of all capital inflows) rose from less than 7% of world GDP in the 1990s to over 20% in 2007 (Milesi-Ferretti and Tille 2011).

financial openness.² Our results suggest that under a more flexible exchange rate the RER appreciation associated with fund inflows is higher, both for equity and bond flows. Furthermore, we find that the coefficient on equity flows tends to be higher in countries with high financial openness, while the coefficient on bond flows is smaller in these countries.

The rest of the paper is organized as follows. Section 2 briefly discusses related studies. Section 3 describes the data. Section 4 examines whether fund flows are related to exchange rate dynamics and section 5 investigates the role of the exchange rate regime and financial openness in this relationship. Section 6 concludes.

2 Related Literature

Two strands of literature are related to our research: (i) studies on the impact of international capital flows on exchange rates; and (ii) research on fund flows.

2.1 Literature on Capital Flows and Exchange Rates

Several studies have examined the role of capital flows in determining exchange rates. For example, Calvo et al. (1993) find that capital inflows to Latin American in the late 1980s and early 1990s are associated with a real exchange rate appreciation and with increased exchange rate volatility. Subsequent studies have examined the impact of different types of international capital flows. For instance, using bilateral exchange rates of the euro and the Japanese yen against the US dollar from 1988Q1 to 2000 Q3, Brooks et al. (2004) conclude that portfolio flows from the euro area to US stock markets closely track the movements between the euro and the US dollar, while FDI flows appear to be less important. Jongwanich and Kohpaiboon (2013) reach a similar conclusion using data of Asian emerging countries during 2000 to 2009. Given the important role of portfolio investments, it is surprising that only few studies focus on the role of portfolio equity and bond flows in exchange rate dynamics. A noteworthy exception is the work by Caporale et al. (2015). Employing monthly bilateral data for US vis-à-vis eight Asian emerging countries, they find that equity inflows tend to lead to high exchange rate volatility. So this suggests that equity and bond flows may have a different impact on exchange rate dynamics. In our study, we differentiate between both types of fund flows.

2.2 Literature on Fund Flows

International fund flows have been examined in several studies. These studies can be divided into two groups: fund-level studies and country-level studies. Fund-level studies focus on the money flowing into or out of each fund, whereas country-level studies concentrate on aggregated funds flowing into or out of a country.

² Combes et al. (2012) analyze the impact of capital inflows on the real effective exchange rate for a sample of 42 emerging and developing countries over the period 1980–2006 and find that a more flexible exchange rate could dampen the exchange rate appreciation associated with capital inflows.

An example of the first group of studies is the work by Raddatz and Schmukler (2012). They find that investors and fund managers show pro-cyclical behavior, which helps transmit crises across countries. Investors tend to pull out of funds that invest in countries undergoing crises and invest more in funds when conditions in their country of origin improve.

An example of the second group is the work by Fratzscher (2012) who investigates push and pull factors driving fund flows based on a sample of 50 countries. He finds that common shocks (push factors) exert a larger effect on fund flows than domestic shocks (pull factors), especial in crisis periods.

In contrast to these studies, this paper investigates the relationship between international fund flows and exchange rate dynamics, which has, to the best of our knowledge, not been examined before.

3 Data

3.1 Data on International Fund Flows

Our data for international fund flows come from EPFR Global, which tracks the asset allocations of more than 62,500 funds globally (as of September 15th, 2014).³ The database offers a wide industry and geographic coverage and data are reported at a high frequency (daily, weekly and monthly). It tracks around 98%–99% of emerging market equity funds, over 95% of ETF assets globally, around 90% of funds in USA and 70%–75% of funds in developed European markets.⁴

International fund flows have increased rapidly since the 1990s. During that time, industrial countries deregulated their financial markets. Emerging markets also increased their capital and trade openness, which have rendered them more attractive to international investors (Gelos 2013). These reforms made it easier for foreign investors to access the local market and for domestic investors to allocate their assets globally (Bekaert and Harvey 1998; Gelos 2013). Consequently, the volume of international fund flows surged over the last two decades. As shown in Fig. 1, assets under management by international funds (covered by the EPFR Global database) increased more than 150 times, expanding from 0.15 trillion US dollars in 2000 to 25 trillion US dollars in 2015. Notably the volume of equity flows increased from less than one billion US dollars in 2000 to 77.4 billion US dollars in 2013.

Depending on their investment target, funds can be classified as equity funds, bond funds, money market funds, balanced funds and alternative funds. Due to data limitations, we only use the fund flows of equity funds (equity flows for short) and bond funds (bond flows for short), which accounts for more than 70% of assets under

³ Some previous studies also used this database (cf. Jinjark et al. 2011; Fratzscher 2012; Raddatz and Schmukler 2012; Yeyati and Williams 2012; and Puy 2016). Using data for 29 major emerging markets from 2005 to 2013, Moussavi (2014) concludes that trends in EPFR Global data largely coincide with trends in gross portfolio capital flows recorded by Balance of Payment statistics.

⁴ The coverage of EPFR Global has increased over the past two decades. Although the coverage of EPFR Global is limited at the very beginning, it is still representative for the fund flow trends. Based on data for 29 major emerging markets from 2005 to 2013, Moussavi (2014) concludes that trends in EPFR Global data largely coincide with trends in gross portfolio capital flows recorded by Balance of Payment statistics.

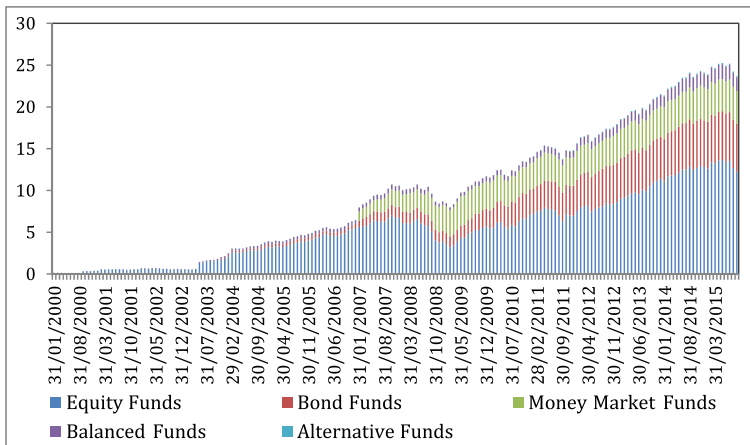


Fig. 1 Total net asset of funds covered by EPFR Global (USD trillions)

management by all funds. These flows capture the inflows (outflows) of equity/bond funds into (out of) a specific country. Following Puy (2016), we scale the fund flows by asset under management (AUM) of each receiving country, which reports the total assets invested in the receiving country by all funds. (In some of our robustness checks we scale fund flows by GDP, which does not affect our findings in a qualitative way.)

We first clean the data. We excluded countries with less than 24 continuous observations and countries whose assets are less than five million U.S. dollars. We delete countries for which macroeconomic data are not available and we omit the United States, because the U.S. dollar is used as reference to calculate the real exchange rate. As a result, we end up with 53 countries in our sample, for the period January 1996 to June 2015 for equity flows and for January 2004 to June 2015 for bond flows. The countries in our sample are listed in Appendix Table 8.

3.2 Data on Exchange Rates

We employ countries' bilateral real exchange rate vis-à-vis the U.S. dollar. We define the bilateral RER (domestic currency against the U.S. dollar) as follows:

$$RER_{d/\$} = \frac{NER_{d/\$} * CPI_{US}}{CPI_d},$$

where $NER_{d/\$}$ is the nominal exchange rate (measured as the domestic currency per U.S. dollar), CPI_{US} and CPI_d are the Consumer Price Index of the U.S. and domestic countries, respectively. An increase of $RER_{d/\$}$ indicates a depreciation of the domestic currency. The log change of the real exchange rate is employed in the empirical models.

3.3 Real Exchange Rate and Fund Flow Nexus: a First Look at the Data

Figure 2 shows fund flows (scaled by AUM) and the RER for a few selected countries. The figure suggests that, generally, fund inflows are associated with an appreciation of the RER. For example, in Brazil the strong increase in fund inflows during 2003–2007

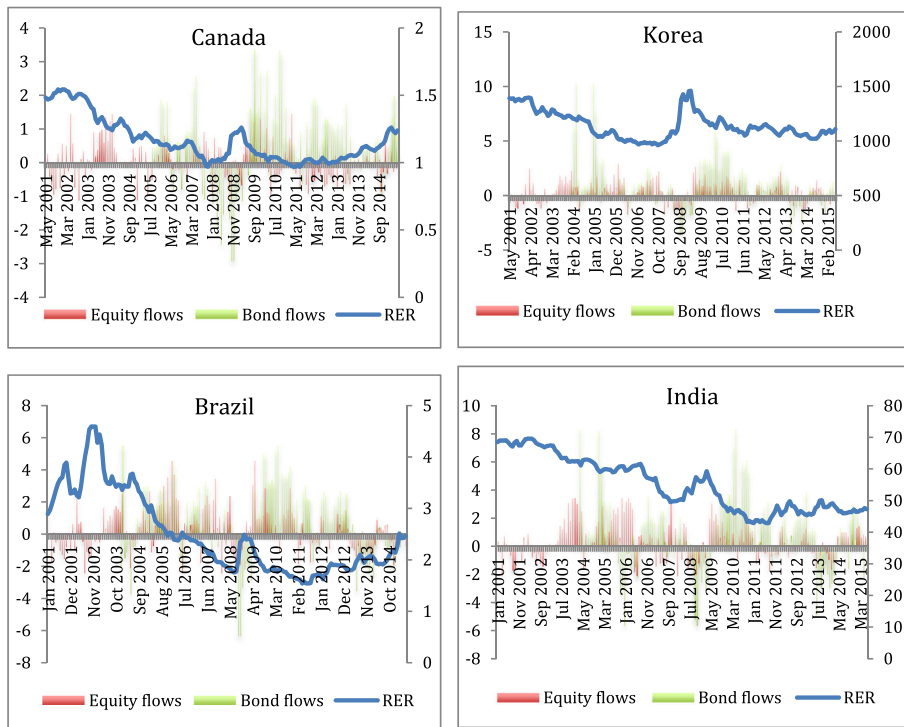


Fig. 2 Fund flows and real exchange rates in some selected countries

is accompanied by an appreciation of Brazil's RER in the same period. During the Global Financial Crisis, global funds tended to withdraw their investments in Brazil and the Real depreciated suddenly and sharply at the same time. Afterwards, fund flows returned which coincided with a real appreciation of the Brazilian exchange rate. In 2013 and 2014, the economic downturn in Brazil led to large-scale outflows of fund investments, which was accompanied by a real depreciation of the Real. The experience of Canada, Korea, and India confirm that fund inflows (outflows) are associated with a currency appreciation (depreciation).

Table 1 shows the accumulated change of the RER during periods with fund inflows and fund outflow for some major developing and developed economies. The table suggests that in periods with fund inflows the RER generally appreciates, whereas in periods with fund outflows the RER depreciates; this holds true especially for equity flows. There are exceptions, though. For instance, the Chinese Renminbi continued to appreciate both in periods with equity inflows and equity outflows. However, the accumulated real appreciation of the Chinese currency is larger in periods with equity inflows.

In the following sections, we further investigate the relationship between fund flows and exchange rate dynamics using econometric models. We also examine whether this relationship differs across developed and developing countries and across countries with different exchange rate regimes and with different levels of financial openness.

Table 1 Accumulated log change of the real exchange rate during periods with fund inflows and fund outflows for some selected countries

	Equity flows >0	Equity flows <0	Bond flows >0	Bond flows <0
Developing countries				
Brazil	-181.314	218.059	-111.542	78.578
China	-6.762	-1.246	-8.852	0.844
India	-77.238	44.643	-63.407	35.643
Indonesia	-106.374	15.338	-45.365	37.887
Malaysia	-45.419	79.528	-39.047	33.378
Mexico	-85.991	72.983	-39.498	54.188
South Africa	-62.651	107.002	-24.969	42.320
Developed countries				
Canada	-58.261	40.257	-22.715	26.612
France	-24.407	8.265	14.204	-0.654
Germany	-20.358	4.954	15.893	-3.241
Korea	-59.753	80.223	-39.926	29.480
Singapore	-38.347	43.757	-39.471	14.299
United Kingdom	-34.190	24.536	-9.339	19.580

This table presents the accumulated log change of the RER during periods with fund inflows and outflows. A negative (positive) value indicates exchange rate appreciation (depreciation)

4 Empirical Results

4.1 Model

A dynamic panel data model is employed to investigate the relationship between fund flows and real exchange rates. The dependent variable is the log change of RER, as described in section 3.2. The explanatory variables of interest are equity flows (EF) and bond flows (BF). The results of Jongwanich and Kohpaiboon (2013) suggest that an increase in portfolio capital flows and bank loans quickly results in a real exchange rate appreciation, while the effect of FDI occurs with a lag. We therefore include contemporaneous fund flows as well as lagged fund flows in the model. The dynamic panel data model is as follows:

$$s_{i,t} = \sum_{j=1}^m \alpha_j s_{i,t-j} + \beta_0 B_{i,t} + \beta_1 B_{i,t-1} + \gamma Z_{i,t-1} + u_i + \varepsilon_{i,t}, \quad (1)$$

where $s_{i,t} = (\ln(RER_{i,t}) - \ln(RER_{i,t-1})) * 100$, $B_{i,t} = [EF_{i,t}, BF_{i,t}]$, $B_{i,t-1} = [EF_{i,t-1}, BF_{i,t-1}]$, EF and BF are equity flows and bond flows, respectively, and $Z_{i,t-1} = [PROD_{i,t-1}, CA_{i,t-1}, TOT_{i,t-1}, OPEN_{i,t-1}, IR_{i,t-1}]$, α , β , γ are parameters to be estimated, while u_i is a country fixed effect and $\varepsilon_{i,t} \sim N(0, \sigma_\varepsilon^2)$. Subscripts i and t denote country i and time t , respectively. According to Kiviet (1995), if the T of panel data is large enough ($T > 30$), the Least-Squares Dummy Variable (LSDV) estimator is valid and more efficient than other estimators. Therefore,

the LSDV method is employed to estimate the model. We also use a GMM estimator to test the robustness of the results.

Following related research (Athukorala and Rajapatirana 2003; Brooks et al. 2004; Combes et al. 2012; Jongwanich and Kohpaiboon 2013), we include several macroeconomic variables as controls, including a proxy for the productivity differential (PROD), the current account balance (CA), a terms of trade variable (TOT), trade openness (OPEN), and the short-term interest rate differential (IR). All the control variables are lagged one period to avoid endogeneity problems. The productivity differential is included to capture the Balassa-Samuelson effect, according to which the increase in productivity in the tradable sector tends to be associated with an exchange rate appreciation due to the higher price increase of non-tradable goods than that of tradable goods (cf. Tang and Zhou 2013). Following Combes et al. (2012), Jongwanich and Kohpaiboon (2013) and Tang and Zhou (2013), the productivity differential is measured as the ratio of real GDP per capita in the domestic country to GDP per capita in the U.S. An increase in this variable implies a productivity improvement in the domestic country. The terms of trade variable is defined as the relative price of a country's export compared to its imports (Tang and Zhou 2013). In constructing this variable, we employ the ratio of the unit value of exports to the unit value of imports. Following Tang and Zhou (2013), for countries for which this data is not available, we instead use the ratio of exports to imports.⁵ Following Jongwanich and Kohpaiboon (2013), trade openness is calculated as the sum of exports and imports divided by nominal GDP. Finally, we include the short-term interest rate differential, which is proxied by a country's 3-month interest rate minus the U.S. three-month T-bill rate (Brooks et al. 2004). Table 2 shows the definition and sources of all the explanatory variables.

4.2 Empirical Results

Table 3 presents the estimation results of Eq. (1), using data of 53 countries between January 1996 and June 2015. The dependent variable is the log change of the real exchange rate. We include contemporaneous as well as lagged fund flows in the model to examine the time lag in the relationship between fund flows and exchange rates. Table 3 provides several interesting results. First, as shown in Column (1), a contemporaneous increase in equity flows and bond flows is associated with a decrease of the RER, that is, an appreciation of the real exchange rate. This result is consistent with the findings of previous studies (cf. Combes et al. 2012; Jongwanich and Kohpaiboon 2013), which conclude that portfolio flows lead to an exchange rate appreciation in the same period.

Second, lagged fund flow also have explanatory power for RER dynamics, as shown in Column (2) in Table 3. However, the coefficient on the lag of the funds flow variable is smaller than that of contemporaneous fund flows as reported in column (1).

⁵ These countries are: Austria, Bulgaria, Chile, China, Croatia, Czech Republic, Egypt, Estonia, Indonesia, Kazakhstan, Lithuania, Malaysia, Mexico, Nigeria, Philippines, Portugal, Qatar, Romania, Russian, Slovenia, South Africa, Switzerland, Tunisia, Ukraine.

Table 2 Definition of variables

Variable	Definition/ Calculation	Reference	Frequency & Data source
Real exchange rate (RER)	$RER_{d/\$} = \frac{NER_{d/\$} * CPI_{US}}{CPI_d}$ $s_t = (\ln(RER_t) - \ln(RER_{t-1})) * 100$	Athukorala and Rajapatirana 2003; Kodongo and Ojah 2012; Jongwanich and Kohpaiboon 2013	Monthly, CEIC, IFS
Nominal exchange rate (NER)	$s_t = (\ln(NER_t) - \ln(NER_{t-1})) * 100$		Monthly, CEIC
Real effective exchange rate (REER)	$s_t = (\ln(REER_t) - \ln(REER_{t-1})) * 100$	Combes et al. 2012; Tang and Zhou 2013	Monthly, CEIC
Equity flows (EF)	International equity fund flows scaled by assets under management of each receiving country (or scaled by nominal GDP)		Monthly, EPFR Global
Bond flows (BF)	International bond fund flows scaled by assets under management of each receiving country (or scaled by nominal GDP)		Monthly, EPFR Global
Productivity differential (PROD)	Ratio of real GDP per capita in domestic country to GDP per capita in the U.S.	Combes et al. 2012; Jongwanich and Kohpaiboon 2013; Tang and Zhou 2013	Annual, CEIC
Terms of trade (TOT)	Ratio of unit value of export to unit value of import (or ratio of exports to imports in case of missing data)	Jongwanich and Kohpaiboon 2013; Combes et al. 2012; Tang and Zhou 2013	Monthly, CEIC, IFS
Trade openness (OPEN)	Sum of exports and imports divided by nominal GDP	Athukorala and Rajapatirana 2003; Jongwanich and Kohpaiboon 2013; Combes et al. 2012; Tang and Zhou 2013	Monthly, CEIC
Short-term interest rate differential (IR)	Country's three-month interests rate minus U.S. three-month T-bill interest rate	Siourounis 2004; Brooks et al. 2004	Monthly, CEIC
Current account balance (CA)	Current account balance as percentage of GDP		
Exchange rate regime (ERA)	Classification of exchange rate regimes	Reinhart and Rogoff 2004; Ilzetzki et al. 2009	Monthly, data online ^a
Financial openness index (KAOPEN)	Takes a higher value if the country is more financial integrated (lower capital controls).	Chinn and Ito 2008	Annual, data online till 2014 ^b ; 2015 takes the same value as 2014

^a Data available online at: <http://www.carmenreinhardt.com/research/publications-by-topic/exchange-rates-and-dollarization/>

^b Data available online at: http://web.pdx.edu/~ito/Chinn-Ito_website.htm

Third, following Jongwanich and Kohpaiboon (2013), we include both contemporaneous as well as lagged fund flows in one model. Column (3) in Table 3 provides the result. For equity flows, the coefficients on both contemporaneous and lagged equity flows are significant, but the coefficient on contemporaneous fund flows is larger and

Table 3 Fund flows and the real exchange rate

	(1) Fund flows	(2) Lagged fund flows	(3) Both
RER(-1)	0.274*** (17.14)	0.303*** (18.54)	0.287*** (18.11)
RER(-2)	-0.127*** (-7.23)	-0.119*** (-6.97)	-0.110*** (-6.33)
RER(-3)	0.0633*** (5.17)	0.0759*** (5.87)	0.0701*** (5.48)
Equity flows	-0.199** (-2.48)		-0.175** (-2.35)
Bond flows	-0.174*** (-7.17)		-0.305*** (-7.81)
Equity flows(-1)		-0.110** (-2.67)	-0.0257 (-0.95)
Bond flows(-1)		-0.00355 (-0.23)	0.200*** (6.87)
Productivity differential(-1)	0.121 (0.23)	1.125** (2.02)	0.206 (0.40)
Current account balance(-1)	0.0167** (2.16)	0.0118 (1.61)	0.0158** (2.12)
Interest rate differential(-1)	0.0350 (1.43)	0.0453* (1.83)	0.0432* (1.73)
Terms of trade(-1)	-0.101 (-1.16)	-0.152 (-1.50)	-0.0928 (-1.10)
Trade openness(-1)	-0.0228 (-0.09)	0.207 (0.72)	-0.0882 (-0.32)
Constant	-0.937** (-2.47)	-1.308*** (-3.70)	-1.111*** (-2.96)
N	5534	5497	5497
Country fixed effects	Yes	Yes	Yes
Time fixed effects	No	No	No
R-squared	0.1482	0.1091	0.1621
Root MSE	2.277	2.3332	2.2632

Dependent variable: log change of RER. Columns (1), (2), and (3) describe the result for the model that includes contemporaneous fund flows only, lagged fund flows only and both contemporaneous and lagged fund flows, respectively. Standard errors are clustered by country; t-statistics in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively

more significant. For bond flows, contemporaneous fund inflows are related to a currency appreciation, but lagged bond flows are associated with a RER depreciation. One possible explanation is that large bond inflows increase demand in the FX market to such an extent that it may lead to overshooting of the exchange rate, which is corrected in the following month.

Table 4 shows the results if we split up the sample in developed and developing countries. We conclude that bond flows are more significantly related to a RER appreciation than equity flows in developing countries, while in developed countries equity flows play a more important role. A reason might be that developed countries attract more equity fund flows as they have more mature stock markets, and therefore the influence of equity flows

Table 4 Fund flows and the real exchange rate: developed versus developing countries

	Developed countries			Developing countries		
	(1) Fund flows	(2) Lagged fund flows	(3) Both	(4) Fund flows	(5) Lagged fund flows	(6) Both
RER(-1)	0.259*** (13.15)	0.279*** (12.76)	0.263*** (13.21)	0.274*** (10.04)	0.320*** (17.89)	0.303*** (16.07)
RER(-2)	-0.0946*** (-4.49)	-0.0952*** (-4.59)	-0.0860*** (-4.08)	-0.184*** (-7.31)	-0.176*** (-7.00)	-0.161*** (-6.06)
RER(-3)	0.0767*** (5.84)	0.0830*** (5.83)	0.0825*** (6.09)	0.0266 (1.21)	0.0549** (2.36)	0.0359 (1.63)
Equity flows	-0.318*** (-4.46)		-0.243*** (-3.16)	-0.133 (-1.63)		-0.130 (-1.63)
Bond flows	-0.121*** (-6.62)		-0.225*** (-7.04)	-0.243*** (-5.04)		-0.411*** (-5.34)
Equity flows(-1)		-0.294*** (-5.63)	-0.181*** (-3.06)		-0.0208 (-1.03)	0.0359 (1.24)
Bond flows(-1)		0.0353* (1.94)	0.179*** (5.46)		-0.0483** (-2.42)	0.240*** (4.77)
Productivity differential(-1)	-0.855 (-1.57)	-0.221 (-0.43)	-1.038* (-1.88)	6.068*** (5.28)	8.861*** (6.25)	6.538*** (5.33)
Current account balance(-1)	0.0216** (2.11)	0.0196** (2.07)	0.0221** (2.08)	0.0205 (1.53)	0.0120 (0.92)	0.0174 (1.53)
Interest rate differential(-1)	0.0844** (2.74)	0.0910*** (2.83)	0.0851*** (2.75)	0.0203 (0.73)	0.0330 (1.33)	0.0300 (1.13)
Terms of trade(-1)	-0.0141 (-0.25)	-0.0404 (-0.69)	0.00292 (0.05)	-0.634 (-1.63)	-0.863* (-2.09)	-0.592 (-1.69)
Trade openness(-1)	-0.202 (-0.69)	-0.0811 (-0.26)	-0.360 (-1.19)	0.696** (2.51)	1.027*** (3.00)	0.718** (2.43)
Constant	-1.469*** (-3.32)	-1.692*** (-3.78)	-1.439*** (-3.30)	-0.710 (-0.99)	-1.332** (-2.46)	-1.035 (-1.72)
N	3446	3420	3420	2088	2077	2077
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	No	No	No	No	No

Dependent variable: log change of RER. Countries are classified according to the World Bank's classification in July 2015. Developed countries include high-income countries and other countries are categorized as developing countries. Standard errors are clustered by country; t-statistics in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively

on the RER is more significant. As emerging countries tend to receive more bond flows (Combes et al. 2012), these are more strongly related to a currency appreciation.

4.3 Robustness Analysis

To address potential endogeneity problems, we re-estimate our models using the Arellano-Bond GMM estimator (Arellano and Bond 1991). We include 3-lagged dependent variables in the dynamic panel data model, and set fund flows as endogenous variables. Further lagged levels of these variables are used as instruments. Table 5 presents

Table 5 Robustness analysis: GMM estimation results

	(1) Full sample	(2) Full sample	(3) Developed countries	(4) Developed countries	(5) Developing countries	(6) Developing countries
RER(-1)	0.0486 (1.45)	0.0932** (2.31)	0.0496 (1.34)	0.0994** (1.99)	-0.228 (-0.82)	-0.0132 (-0.03)
RER(-2)	-0.244*** (-11.64)	-0.210*** (-8.30)	-0.200*** (-5.33)	-0.181*** (-4.77)	-0.542*** (-2.58)	-0.309 (-1.64)
RER(-3)	-0.120*** (-3.16)	-0.0943** (-2.12)	-0.0811 (-1.55)	-0.0446 (-0.75)	-0.581 (-1.34)	0.0866 (0.32)
Equity flows	-0.256*** (-2.82)	-0.210** (-2.27)	-0.431** (-2.37)	-0.337 (-1.06)	-0.567** (-2.08)	0.296 (0.83)
Bond flows	-0.366*** (-7.16)	-0.399*** (-5.41)	-0.327** (-2.50)	-0.275** (-2.21)	-0.201 (-1.22)	-1.163** (-2.56)
Equity flows(-1)		-0.0247 (-0.20)		-0.379 (-1.40)		0.937 (1.60)
Bond flows(-1)		0.121** (2.28)		0.140 (1.00)		-0.854 (-1.57)
Productivity differential(-1)	8.147 (1.47)	6.516 (1.30)	6.200 (0.89)	5.242 (0.82)	22.59 (0.14)	-168.8 (-1.27)
Current account balance(-1)	0.0103 (0.74)	-0.00238 (-0.19)	0.0173 (0.60)	0.0167 (0.74)	0.186* (1.79)	-0.0892 (-0.50)
Interest rate differential(-1)	-0.0389 (-0.45)	0.0350 (0.40)	-0.0752 (-0.95)	-0.0353 (-0.18)	0.00422 (0.04)	0.0312 (0.25)
Terms of trade(-1)	-0.160 (-0.81)	-0.117 (-0.85)	-0.139 (-0.85)	-0.763 (-0.52)	-15.76 (-1.51)	9.040 (0.66)
Trade openness(-1)	-0.567 (-0.50)	0.413 (0.32)	-0.591 (-0.34)	-1.147 (-0.42)	-15.81 (-0.69)	12.77 (1.39)
Constant	-3.196 (-1.25)	-3.689 (-1.59)	-3.872 (-0.59)	-1.950 (-0.36)	23.13 (0.58)	3.703 (0.18)
N	5484	5447	3414	3388	2070	2059

Dependent variable: log change of RER. To address potential endogeneity problems, we re-estimate the models of Table 4 using GMM. Standard errors are clustered by country; t-statistics in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively

the result. Arellano-Bond tests indicate that there is no serial correlation in the disturbance terms, and the Sargan tests show that over-identifying restrictions for instrument variables are valid, suggesting that our model is appropriate.

The results reported in Table 5 are quite similar to those of our baseline model. Contemporaneous fund flows are negatively related with the log change of the RER, implying that large inflows of international fund investments are related to a currency appreciation. Lagged equity flows are not significant and lagged bond flows are positively related with RER dynamics. Regarding the difference between developed and developing countries, the GMM estimates also suggest that bond flows have a more significant effect on RER appreciation than equity flows in developing countries.

Table 6 shows some further robustness checks. Following Combes et al. (2012) and Tang and Zhou (2013), we first replace the real exchange rate (RER) with the real effective exchange rate (REER) in Column (1). An increase in REER indicates the appreciation of domestic currency. We conclude that contemporaneous fund flows are associated with currency appreciation, but it is not significant. This may not be surprising. Most cross-border fund investments are conducted in U.S. dollars. Therefore, the price-adjusted bilateral exchange rate vis-à-vis the U.S. dollar is more sensitive to fund flows than the REER. In Column (2), the RER is replaced by the nominal exchange rate giving similar results as for the real exchange rate. Finally, in Column (3) we scale fund flows by nominal GDP instead of AUM (see also Jongwanich and Kohpaiboon 2013). Our main findings do not change.

5 The Role of the Exchange Rate Regime and Financial Openness

Combes et al. (2012) conclude that a more flexible exchange rate regime could effectively dampen the REER appreciation associated with capita inflows. To examine whether it is also the case with fund flows, we include the interaction term of fund flows and exchange rate regime indicators (ERA) in our second model. We employ the de facto classification of regimes developed by Reinhart and Rogoff (2004) and updated by Ilzetzi et al. (2008). They code exchange rate regimes on a scale from 1 to 6.⁶ The estimated model is as follows:

$$s_{i,t} = \sum_{j=1}^m \alpha_j s_{i,t-j} + \beta_0 B_{i,t} + \theta_1 B_{i,t} * ERA_{i,t} + \eta_1 ERA_{i,t} + \gamma Z_{i,t-1} + u_i + \varepsilon_{i,t}. \quad (2)$$

The setting is the same as for Eq. (1) except that we add the exchange rate regime indicator and an interaction term of fund flows and ERA. θ_1 is the

⁶ The index is one for four exchange rate arrangements: no separate legal tender, pre-announced peg or currency board arrangement, pre-announced horizontal band that is narrower than or equal to $\pm 2\%$, and de facto peg. It is two for four exchange rate arrangements: pre-announced crawling peg, pre-announced crawling band that is narrower than or equal to $\pm 2\%$, de facto crawling peg, and de facto crawling band that is narrower than or equal to $\pm 2\%$. The index is three for regimes with a pre-announced crawling band that is wider than or equal to $\pm 2\%$, with a de facto crawling band that is narrower than or equal to $\pm 5\%$, moving band that is narrower than or equal to $\pm 2\%$ (i.e., allows for both appreciation and depreciation over time), and with managed floating. It is four for exchange rates that are freely floating. The index is five for countries that are freely falling, and six for countries with a dual market and where parallel market data is missing.

Table 6 Robustness analysis: other variables

	(1) Log change of REER	(2) Log change of NER	(3) Fund flows scaled by GDP
Y(-1)	0.271 ^{**} (12.57)	0.319 ^{***} (17.31)	0.304 ^{***} (18.42)
Y(-2)	-0.0809 ^{**} (-2.44)	-0.0949 ^{***} (-6.19)	-0.110 ^{***} (-6.59)
Y(-3)	0.0111 (0.70)	0.0706 ^{***} (5.87)	0.0723 ^{***} (5.69)
Equity flows	0.0404 (0.94)	-0.177 ^{**} (-2.57)	-31.51 ^{**} (-2.04)
Bond flows	0.0548 (1.27)	-0.301 ^{***} (-7.61)	-89.28 ^{***} (-4.26)
Equity flows(-1)	0.00457 (0.23)	-0.0347 (-1.34)	3.208 (0.51)
Bond flows(-1)	-0.0245 (-0.77)	0.180 ^{***} (5.89)	49.14 ^{***} (2.75)
Productivity differential(-1)	-0.200 (-0.63)	0.389 (0.91)	0.728 (1.41)
Current account balance(-1)	-0.00826 (-1.36)	0.0114 [*] (1.87)	0.0119 (1.62)
Interest rate differential(-1)	-0.0157 (-0.86)	0.0608 ^{***} (2.75)	0.0480 [*] (1.97)
Terms of trade(-1)	0.529 [*] (1.75)	-0.179 [*] (-1.70)	-0.110 (-1.22)
Trade openness(-1)	-0.0904 (-0.44)	0.266 (1.13)	0.251 (0.98)
Constant	-0.225 (-0.51)	0.390 (1.59)	-1.329 ^{***} (-3.97)
N	5771	5963	5492
Country fixed effects	Yes	Yes	Yes
Time fixed effects	No	No	No

This table presents the results of some robustness tests. In column (1), the dependent variable is the log change of REER. In column (2), the dependent variable is the log change of NER. In column (3), we scale equity flows and bond flows by nominal GDP instead of assets under management. Standard errors are clustered by country; t-statistics in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively

parameter for the interaction term of fund flows and ERA. If the parameter $\theta_1 < 0$, fund flows tend to be stronger associated with a RER appreciation in countries with more flexible exchange rate regimes.

Similarly, we also examine whether the financial openness of an economy influences the relationship between fund flows and the RER. We employ the KAOPEN index as a measure of financial openness, which is a de jure index of capital controls calculated by

Table 7 The role of the exchange rate regime and financial openness

	(1)	(2)
RER(−1)	0.291 ^{***} (16.78)	0.269 ^{***} (16.85)
RER(−2)	−0.215 ^{***} (−10.85)	−0.127 ^{***} (−7.13)
RER(−3)	0.127 ^{***} (5.95)	0.0618 ^{***} (5.02)
Equity flows	0.278 ^{**} (2.15)	−0.191 ^{***} (−3.35)
Bond flows	−0.112 ^{**} (−2.68)	−0.210 ^{***} (−6.93)
ERA	0.0486 (0.35)	
ERA*Equity flows	−0.215 ^{***} (−3.49)	
ERA*Bond flows	−0.0289 (−1.43)	
KAOPEN		−0.0665 (−0.68)
KAOPEN*Equity flows		−0.0602 ^{**} (−2.14)
KAOPEN*Bond flows		0.0385 ^{***} (2.94)
Productivity differential(−1)	0.958 (1.28)	0.00169 (0.00)
Current account balance(−1)	0.0168 (1.46)	0.0176 ^{**} (2.29)
Interest rate differential(−1)	0.0420 [*] (1.87)	0.0312 (1.32)
Terms of trade(−1)	−0.332 (−0.93)	−0.101 (−1.17)
Trade openness(−1)	−0.227 (−0.61)	−0.0112 (−0.04)
Constant	−0.146 (−0.20)	−0.986 ^{**} (−2.67)
<i>N</i>	3112	5534
Country fixed effects	Yes	Yes
Time fixed effects	No	No
R-squared	0.1934	0.1516
Root MSE	2.46	2.2731

This table examines the role of the exchange rate regime (ERA) and financial openness (KAOPEN) in the relationship between fund flows and real exchange rates. Dependent variable: log change of RER. Standard errors are clustered by country; t-statistics in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively

Chinn and Ito (2008). This index takes a higher value if the country has fewer capital controls. The estimated model is as follows:

$$s_{i,t} = \sum_{j=1}^m \alpha_j s_{i,t-j} + \beta_0 B_{i,t} + \theta_2 B_{i,t} * KAOPEN_{i,t} + \eta_2 KAOPEN_{i,t} + \gamma Z_{i,t-1} + u_i + \varepsilon_{i,t}, \quad (3)$$

We add an interaction term of fund flows and KAOPEN. θ_2 is the parameter for this interaction term. If $\theta_2 < 0$, large fund inflows are associated with larger RER appreciation in countries with higher financial openness.

Table 7 reports the estimation results for Eqs. (2) and (3). The following conclusions can be drawn. First, the coefficient on the interaction term of equity flows and ERA is significantly negative, implying that in countries with a more flexible exchange rate regime, equity flows are more strongly related to a RER appreciation than in countries with a less flexible exchange rate regime.

Second, the coefficient on the interaction term of equity flows and KAOPEN is also significantly negative. This indicates that if a country has more open capital account, equity flows are more strongly related to a RER appreciation. However, bond flows have less effect in more financially integrated countries. But the total effect of bond flows is still negative as the sum of the coefficient on bond flows and bond flows*KAOPEN is negative. One possible explanation is that for more financially integrated countries, stock markets are highly developed and they attract large amount of fund investments. Therefore, their exchange rates are more sensitive to equity investments.

6 Conclusions

Due to the increased financial integration and capital market liberalization, the volume of international fund flows has increased significantly since the 1990s. Their rapid increase and high volatility make it highly relevant to investigate the relationship between fund flows and exchange rate dynamics.

Using monthly data of 53 countries over a period of twenty years in a dynamic panel data model, we find that large fund inflows are associated with a real domestic currency appreciation. Splitting the sample in developed and developing countries, we find that the coefficient on bond flows is more significant than that on equity flows in developing countries, while in developed countries equity flows play a more important role.

Furthermore, we examine the role of the exchange rate regime and financial openness in the relationship between fund flows and the RER. Different from Combes et al. (2012), we conclude that under a more flexible exchange rate regime there is a stronger association between fund inflows and a RER appreciation, both for equity flows and bond flows. Our results also suggest that the relationship between equity flows and a RER appreciation tends to be larger in countries with a higher level of financial openness, but the reverse holds for bond flows.

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Appendix

Table 8 Countries in the sample

No.	Country	No.	Country	No.	Country
1	Argentina	19	Greece	37	Philippines
2	Australia	20	Hong Kong	38	Poland
3	Austria	21	Hungary	39	Portugal
4	Belgium	22	India	40	Qatar
5	Brazil	23	Indonesia	41	Romania
6	Bulgaria	24	Ireland	42	Russia
7	Canada	25	Israel	43	Singapore
8	Chile	26	Italy	44	Slovenia
9	China	27	Japan	45	South Africa
10	Colombia	28	Kazakhstan	46	Spain
11	Croatia	29	Korea	47	Sweden
12	Czech Republic	30	Lithuania	48	Switzerland
13	Denmark	31	Malaysia	49	Thailand
14	Egypt	32	Mexico	50	Tunisia
15	Estonia	33	Netherlands	51	Turkey
16	Finland	34	New Zealand	52	Ukraine
17	France	35	Nigeria	53	United Kingdom
18	Germany	36	Norway		

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